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HNF-SD-WM-ER-649, Rev. 0

Preliminary Tank Characterization Report for Single-Shell Tank 241-AX-101: Best-Basis Inventory

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Abstract: An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for the various waste management activities. As part of this effort, an evaluation of available information for single-shell tank 241-AX-101 was performed, and a best-basis inventory was established. This work follows the methodology that was established by the standard inventory task.

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PRELIMINARY TANK CHARACTERIZATION REPORT FOR SINGLE-SHELL TANK 241-AX-101: BEST-BASIS INVENTORY

July 1997

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PRELIMINARY TANK CHARACTERIZATION REPORT FOR SINGLE-SHELL TANK 241-AX-101: BEST-BASIS INVENTORY

This document is a preliminary Tank Characterization Report (TCR). It only contains the current best-basis inventory (Appendix D) for single-shell tank 241-AX-101. No TCRs have been previously issued for this tank, and current core sample analyses are not available. The best-basis inventory, therefore, is based on an engineering assessment of waste type, process flow sheet data, early sample data, and/or other available information.

The *Standard Inventories of Chemicals and Radionuclides in Hanford Site Tank Wastes* (Kupfer et al. 1997) describes standard methodology used to derive the tank-by-tank best-basis inventories. This preliminary TCR will be updated using this same methodology when additional data on tank contents become available.

REFERENCE

Kupfer, M. J., A. L. Boldt, B. A. Higley, K. M. Hodgson, L. W. Shelton, B. C. Simpson, and R. A. Watrous (LMHC), S. L. Lambert, and D. E. Place (SESC), R. M. Orme (NHC), G. L. Borsheim (Borsheim Associates), N. G. Colton (PNNL), M. D. LeClair (SAIC), R. T. Winward (Meier Associates), and W. W. Schulz (W^{2}S Corporation), 1997, *Standard Inventories of Chemicals and Radionuclides in Hanford Site Tank Wastes*, HNF-SD-WM-TI-740, Rev. 0, Lockheed Martin Hanford Corporation, Richland, Washington.

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APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-AX-101

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APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-AX-101

An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for the various waste management activities (Hodgson and LeClair 1996). As part of this effort, an evaluation of available information for single-shell tank 241-AX-101 was performed, and a best-basis inventory was established. This work, detailed in the following sections, follows the methodology that was established by the standard inventory task.

D1.0 CHEMICAL INFORMATION SOURCES

Tank 241-AX-101 has not been recently sampled and a Tank Characterization Report (TCR) has not been prepared. The Hanford Defined Waste (HDW) model (Agnew et al. 1997a) provides tank contents estimates, derived from process flowsheets and waste volume records.

As described in Section D3.0, various solutions were received into this tank. As described by the HDW model, residual sludges remaining after 1976 sluicing included 11.35 kL (3 kgal) of strontium recovery (SRR) sludge. Subsequent use left 2,820 kL (745 kgal) of Supernatant Mixing Model 242-A Evaporator salt cake generated from 1976 until 1980 (SMMA1).

D2.0 COMPARISON OF COMPONENT INVENTORY VALUES

No current analyses of SRR sludges are available; however, application of the HDW SRR sludge compositions to the small SRR volume ratioed to the volume of sludge deposited in 241-AX-101 may provide a reasonable assessment of the sludge compositions. The summary of nonradioactive and radioactive constituents of this sludge analysis are contained in Tables D2-1 and D2-2, respectively. The chemical species are reported without charge designation per the best-basis inventory convention.

SMMA1 salt cake analyses have been conducted upon samples withdrawn from both tanks 241-A-102 and 241-A-103. As was represented in the standard inventory assessment for tank 241-AX-103 (Lambert and Hendrickson 1997), these salt cakes, with adjustment for iron, silica, and nickel are expected to yield a reasonable estimate of the composition and inventory of Supernatant Mixing Model 242-S Evaporator salt cake generated from 1973 until 1976 (SMMA1) salt cake within tank 241-AX-101. The summary of nonradioactive and radioactive constituents for this salt cake analysis are contained in Tables D2-3 and D2-4, respectively.

Table D2-1. Estimated Inventory of Strontium Recovery Sludge Nonradioactive Components in Tank 241-AX-101 Waste Sludge.

Analyte	Average SRR sludge concentration (*M*)[a]	SRR projected inventory, kg[b]	Analyte	Average SRR sludge concentration (*M*)[a]	SRR projected inventory, kg[b]
Density, g/mL	1.322	1.322	OH	3.96	764
Ca	0.137	62.2	Si as SiO_3	1.80	1,553
Cl	0.054	21.0	S as SO_4	0.088	95.7
TIC as CO_3	0.341	232	TOC	4.38	598
Fe	1.28	811	EDTA	0.129	428
K	0.012	5.33	NH_3	0.134	25.9
Na	6.46	1,688	H_2O	60.5	9,082
NO_2	0.558	291	Pu	9.07 E-04	2.46
NO_3	3.88 E-07	2.73 E-04	Volume (kL)	11.4	11.4

NR = Not reported
SRR = Strontium recovery sludge
[a] Composition based upon Hanford Defined Waste (Agnew et al. 1997a)
[b] Based upon a volume of 11.4 kL (3 kgal) of sludge in 241-AX-101.

Table D2-2. Estimated Inventory of Strontium Recovery Sludge Radioactive Components in Tank 241-AX-101 Waste Sludge (Decayed to January 1, 1994).

Analyte	Average SRR sludge concentration (Ci/L)[a]	SRR projected inventory (Ci)[b]	Analyte	Average SRR sludge concentration (Ci/L)[a]	SRR projected inventory (Ci)[b]
^{3}H	8.30 E-05	0.943	^{227}Ac	2.12 E-07	0.0024
^{14}C	6.77 E-06	0.077	^{228}Ra	1.86 E-13	2.11 E-09
^{59}Ni	6.10 E-04	6.93	^{229}Th	3.09 E-11	3.51 E-07
^{60}Co	1.37 E-05	0.156	^{231}Pa	3.17 E-07	0.0036
^{63}Ni	0.060	681	^{232}Th	2.51 E-15	2.85 E-11
^{79}Se	3.40 E-04	3.86	^{232}U	8.20 E-12	9.31 E-08
^{90}Sr	9.57	108,717	^{233}U	1.15 E-13	1.31 E-09
^{90}Y	9.57	108,717	^{234}U	3.43 E-08	3.90 E-04
^{93m}Nb	0.0013	14.3	^{235}U	1.34 E-09	1.52 E-05
^{93}Zr	0.0015	16.7	^{236}U	2.26 E-09	2.57 E-05
^{99}Tc	4.57 E-05	0.519	^{237}Np	1.45 E-07	0.0016
^{106}Ru	2.63 E-06	0.030	^{238}Pu	4.77 E-04	5.42
^{113m}Cd	0.0031	35.5	^{238}U	2.75 E-08	3.12 E-04
^{125}Sb	8.09 E-05	0.19	^{239}Pu	0.0128	145
^{126}Sn	5.46 E-04	6.20	^{240}Pu	0.00238	27.0
^{129}I	8.89 E-08	0.001	$^{239/240}Pu$	0.0152	171
^{134}Cs	9.76 E-06	0.111	^{241}Am	0.0144	164
^{137}Cs	0.177	2,006	^{241}Pu	0.0338	384
^{137m}Ba	0.167	1,898	^{242}Cm	1.21 E-05	0.137
^{151}Sm	1.27	14,439	^{242}Pu	1.99 E-07	0.0023
^{152}Eu	3.18 E-04	3.61	^{243}Am	7.55 E-07	0.0086
^{154}Eu	0.0075	84.9	^{243}Cm	1.09 E-06	0.0124
^{155}Eu	0.0195	221	^{244}Cm	4.42 E-05	0.502
^{226}Ra	4.10 E-08	4.66 E-04			

NR = Not reported
SRR = Strontium recovery sludge
[a] Composition based upon Hanford Defined Waste.
[b] Based upon a volume of 11.4 kL of sludge in 241-AX-101.

Table D2-3. SMMA1 Salt Cake Composition and Inventory Projections for Tank 241-AX-101 Based on Core Samples from Tanks 241-A-102 and 241-A-103 and Auger Samples from Tank 241-A-102. (2 Sheets)

Analyte	241-A-102 sample data		Tank 241-A-103 core sample data (μg/g)[b]	Average analyte concentration in SMMA1 salt cake (μg/g)	Estimated inventory of SMMA1 salt cake in tank 241-AX-101 (kg)[c]
	1986 core sample (μg/g)[a]	1996 auger sample (μg/g)[a]			
Density	1.59	1.7	1.345	1.495	1.495
Ag	247	371	24.7	167	704
Al	23,265	31,700	16,570	22,026	92,863
B	14.2	NR	22.3	18.2	76.8
Ba	882	139	575	543	2,289
Bi	1,738	336	176	607	2,558
Ca	2,592	690	1,716	1,678	7,075
Cd	65	NR	80	72	305
TIC as CO_3	NR	21,700	NR	21,700	91,487
Cr	5,270	8,800	1,531	4,283	18,057
Cu	82.0	NR	12.3	47	199
F	NR	277	NR	277	1,168
Fe	13,936	19,600	355	8,561	36,094
K	2,816	3,080	2,534	2,741	11,554
La	NR	103	NR	103	434
Mg	1,382	NR	795	1,088	4,589
Mn	2,151	3,380	124	1,445	6,091
Na	187,045	129,000	208,605	183,314	772,852
Ni	526	413	93.2	281	1,186
NO_2	NR	83,200	NR	83,200	350,772
NO_3	178,500	90,300	113,500	123,950	522,574
Pb	1,186	1,410	364	831	3,503
P as PO_4	16,061	4,906	NR	10,483	44,198
P	5,238	NR	2,170	3,704	15,617
Si	16,530	3,920	16,550	13,387	56,441
S as SO_4	NR	4,480	NR	4,480	18,888
Sr	97.6	31.5	12.0	38	161

Table D2-3. SMMA1 Salt Cake Composition and Inventory Projections for Tank 241-AX-101 Based on Core Samples from Tanks 241-A-102 and 241-A-103 and Auger Samples from Tank 241-A-102. (2 Sheets)

Analyte	241-A-102 sample data		Tank 241-A-103 core sample data (μg/g)[b]	Average analyte concentration in SMMA1 salt cake (μg/g)	Estimated inventory of SMMA1 salt cake in tank 241-AX-101 (kg)[c]
	1986 core sample (μg/g)[a]	1996 auger sample (μg/g)[a]			
TOC	7,570	14,850	7,885	9,548	40,252
U_{TOTAL}	1,041	35,300	1,435	9,803	41,327
Zn	105	NR	54.0	79	335
Zr	1,439	NR	209	824	3,474
H_2O	348,000	343,000	402,000	373,750	1.576 E+06
SMMA1 Volume (L)					2.82 E+06

HDW = Hanford Defined Waste
NR = Not reported
SSR = Strontium recovery sludge
SMMA1 = Supernatant Mixing Model 242-A Evaporator salt cake generated from 1976 until 1980
TCR = Tank Characterization Report
[a] Jo et al. (1996)
[b] Based on mean of two composite core samples from tank 241-A-103 (Weiss and Schull 1988)
[c] Based on 2,820 kL of SMMA1 salt cake, with an average density of 1.495 kg/L. This estimate was derived by averaging the core and auger sample results for tank 241-A-102, and then averaging the results for tanks 241-A-102 and 241-A-103.

Table D2-4. Analytical Results and Tank Inventory Estimates for Radioactive Components in SMMA1 Salt Cake in Tank 241-AX-101 Based on Samples from Tanks 241-A-102 and 241-A-103 (Decayed to January 1, 1994).

Analyte	241-A-102 sample data		Tank 241-A-103 core sample data (μCi/g)	Average analyte concentration in SMMA1 salt cake (μCi/g)	Estimated inventory of SMMA1 salt cake in tank 241-AX-101[a] (Ci)
	1986 core sample (μCi/g)	1996 auger sample (μCi/g)			
^{14}C	0.0012	NR	0.0026	0.0019	7.84
^{60}Co	0.299	NR	0.033	0.166	700
^{90}Sr	503	NR	40.5	272	1.145 E+06
^{90}Y	451	NR	40.5	246	1.036 E+06
^{99}Tc	0.10	NR	0.117	0.109	458
^{129}I	3.90 E-05	NR	9.50 E-06	2.42 E-05	0.102
^{137}Cs	117	NR	169	143	601,782
^{137m}Ba	110	NR	160	135	569,286
$^{239/240}Pu$	2.00	NR	0.130	1.07	4,492
^{241}Am	1.20	NR	0.120	0.658	2,775

HDW = Hanford Defined Waste
NR = Not reported
SMMA1 = Supernatant mixing model A1 salt sake
[a] Based on 2,820 kL of SMMA1 salt cake, with an average density of 1.495 kg/L. This estimate was derived by using the SMMA1 concentrations.

D3.0 COMPONENT INVENTORY EVALUATION

The following evaluation of tank contents is performed in order to identify potential errors and/or missing information that would influence the sampling-based and HDW model component inventories.

The HDW model is mainly based on process production waste compositions, waste transaction records for each tank and assumed solubilities for key components. The sample and process based estimate is based upon HDW-based SRR sludge compositions and SMMA1 salt cake samples from tanks 241-A-102 and 241-A-103. The sample and process based estimate does not encompass Plutonium-Uranium Extraction (PUREX) neutralized high-level (P2) waste of which 38 kL (10 kgal) is described as present by the Waste Status and Transaction Record Summary (WSTRS) model (Agnew et al 1997b) because that model describes its placement into the tank, following sluicing in 1975 to 1976, as P2 waste was produced from 1963 to 1967 it is not credible that direct placement of this waste type occurred in this tank. The volume ascribed to P2 waste is assumed to be SMMA1 salt cake from the subsequent operations yielding approximately 99.6 percent salt cake by volume in the tank.

Table D3-1 tabulates a comparison between the HDW model compositions for nonradioactive components with that estimated from sample data and limited (SRR sludge) HDW model input.

Table D3-1. Comparison of Data and Process-Based and Hanford Defined Waste Inventory Estimates for Nonradioactive Components in Tank 241-AX-101. (2 Sheets)

Analyte	HDW model (kg)[a]	Sample and process based (kg)[b]
Density (g/mL)	1.54	1.494
Heat load (kW)	10.39	4.19[c]
Ag	NR	704
Al	116,000	92,863
B	NR	76.8
Ba	NR	2,289
Bi	654	2,558
Ca	3,241	7,137
Cd	NR	305
TIC as CO_3	79,185	91,720
Cr	15,413	18,057
F	3,260	1,168
Fe	8,370	36,904

Table D3-1. Comparison of Data- and Process-Based and Hanford Defined Waste Inventory Estimates for Nonradioactive Components in Tank 241-AX-101. (2 Sheets)

Analyte	HDW model (kg)[a]	Sample and process based (kg)[b]
Hg	5.08	NR
K	6,472	11,560
La	7.86	434
Mg	NR	4,589
Mn	645	6,091
Na	791,190	774,539
Ni	882	1,186
NO_2	290,310	351,063
NO_3	671,000	522,574
Pb	718	3,503
P as PO_4	22,500	44,198
Si	7,520	57,998
S as SO_4	70,600	18,983
Sr	0	161
TOC	56,298	40,850
U_{TOTAL}	4,910	41,327
Zn	NR	335
Zr	22.1	3,474
H_2O	2,666,891	1.585 E+06
Volume (kL)	2,831	2,831

HDW = Hanford Defined Waste
NR = Not reported
[a] Agnew et al. (1997a)
[b] Summation of Tables D2-1 and D2-3
[c] Kummerer (1995)

Table D3-2. Comparison of Sample and Process Based and Hanford Defined Waste Inventory Estimates for Radioactive Components in Tank 241-AX-101 (Decayed to January 1, 1994). (2 Sheets)

Analyte	HDW model (Ci)[a]	Sample and process based (Ci)[b]
^{14}C	98.8	7.91
^{60}Co	126	700
^{90}Sr	1.02 E+06	1.254 E+06

Table D3-2. Comparison of Sample and Process Based and Hanford Defined Waste Inventory Estimates for Radioactive Components in Tank 241-AX-101 (Decayed to January 1, 1994). (2 Sheets)

Analyte	HDW model (Ci)[a]	Sample and process based (Ci)[b]
^{90}Y	1.02 E+06	1.254 E+06
^{99}Tc	753	458
^{129}I	1.45	0.103
^{137}Cs	7.54 E+05	603,788
^{137m}Ba	7.13 E+05	571,183
$^{239/240}Pu$	435	5,021
^{241}Am	466	2,939

HDW = Hanford Defined Waste
[a] Agnew et al. (1997a)
[b] Summation of Tables D2-2 and D2-4

D3.1 CONTRIBUTING WASTE TYPES

Tank 241-AX-101 was put into service in 1965. Initial tank receipts included aged supernatant wastes, organic wash waste and B Plant fission product waste. Typically theses wastes were received from other tanks rather than directly from the plants. Steam coils were added to the tank in 1966 and the tank was used to concentrate the PUREX High-level waste (HLW), organic wash waste and B Plant fission product additions. During 1968 and 1969 the tank was used to accumulate strontium and cesium recovery waste for staging to tank 241-A-102. The tank received little transfer activity until the end of 1973 when most of the supernatant was removed. PUREX sludge supernatant liquor (PSS) was sent to the tank in 1973 and 1974. Pumping and sluicing of the tank contents for strontium and cesium recovery in 1975-1976 reduced the tank solids inventory to 4.5 kL (1.2 kgal) solids (Rodenhizer 1987) [11.4 kL (Agnew et al 1997b)].

After sluicing, tank 241-AX-101 received product slurry from the 242-A Evaporator (1976 through 1980). Several evaporator products were added to tank 241-AX-101 including Evaporator Bottoms, Hanford Defense Residual Liquid, and Double-Shell Slurry Feed. The tank also received complexed waste.

The current waste volumes for tank 241-AX-101 are shown in Table D3-3 (Hanlon 1996).

Table D3-3. Waste Inventory of Tank 241-AX-101 (Hanlon 1996).

Waste	Volume (kL)	Volume (kgal)
Sludge	11.4	3
Salt cake	2,820	745
Supernatant	30	0
Drainable liquid	1,211	320
Total waste	2,831	748

Table D3-4 summarizes the documented quantities of waste discharged to tank 241-AX-101 from the HDW model waste transaction database (Agnew et al. 1997b). Table entries with negative values are for transfers out of the tank. Quantities removed by self concentration have not been included. These records indicate that the solids in this tank should be mostly salts from concentration of dilute wastes.

Table D3-4. Waste Transaction Information[a] for Tank 241-AX-101. (2 Sheets)

Waste source	Waste volume (kL)	Waste volume (kgal)
PUREX sludge supernatant, organic wash waste, B Plant Fission Product Waste	3,198	845
B Plant Fission Product Waste	12,933	3,417
Moved to tank 241-A-102, 241-AX-102, 241-AX-103	-8,456	-2,234
PUREX sludge supernatant	3,229	853
Moved to 241-A-102, 241-AX-102	-1,737	-459
B waste (acid waste after Sr removal at B Plant)	14,769	3,902
Moved to 241-A-102, 241-AX-103	-17,252	-4,558
PUREX sludge supernatant	4,031	1,065
Moved to 241-AX-103, 241-A-103	-3,274	-865
Sr Recovery waste	764	202
Tank sluiced to B Plant via AR Vault, 241-AX-103	-2,055	-543
Sluiced tank empty except for 11.4 kL (3 kgal) sludge heel		
EVAP	3,622	957
RESD, DSSF	10,288	2,718
To 241-A-102	-10,746	-2,839

Table D3-4. Waste Transaction Information[a] for Tank 241-AX-101. (2 Sheets)

Waste source	Waste volume (kL)	Waste volume (kgal)
DSSF	2,737	723
Moved to 241-AW-103	-2,998	-792
Salt well liquid moved to 241-AN-103	-53	-14
Total Waste Added post sluicing	16,646	4,398
Total Waste Removed post sluicing	-13,796	-3,645
Current Inventory	2,831	748

DSSF = Double-shell slurry feed
EVAP = Evaporator feed
HLW = High-level waste
PUREX = Plutonium-uranium extraction (plant or process)
RESD = Residual evaporator liquor
[a] Agnew et al. (1997b).

The types of solids accumulated in tank 241-AX-101 reported by various authors are compiled in Tables D3-5 and D3-6. Waste types in brackets are expected to have been removed when the tank was sluiced in 1976. The remaining heel is, historically, most likely SRR sludge.

Table D3-5. Expected Solids for Tank 241-AX-101.

Reference	Waste type
Anderson (1990)	[OWW, FP, B, PSS], Resid., DSSF, NCPLX, CPLX,
SORWT model (Hill et al. 1995)	DSSF, NCPLX, EVAP
WSTRS (Agnew et al. 1997b)	[FP, SU, OWW, B, PL, PSS, SRR], EVAP, RESD, DSSF, NCPLX, CPLX
HDW model (Agnew et al. 1997a)	SRR, P2, SMMA1

B = B Plant Waste
DSSF = Double-shell slurry feed
FP = Fission product waste
NCPLX = Non-Complexed Waste
P2 = PUREX Neutralized High-Level Waste
PSS = PUREX sludge supernatant
SMMA1 = Supernatant mixing model A1 salt cake
SORWT = Sort on radioactive waste type
WSTRS = Waste status and transaction record summary.
CPLX = Complexed waste
EVAP = Evaporator feed
HDW = Hanford Defined Waste
OWW = Organic Wash Waste
PL = PUREX low-level waste
Resid. = Residual
SRR = Strontium recovery
SU = Supernatant

Table D3-6. Hanford Defined Waste Model Solids for Tank 241-AX-101.

Hanford Defined Waste solids layer	kL	kgal
SRR	11.4	3
P2	37.9	10
SMMA1	2,782	735

SMMA1 = Supernatant Mixing Model A1 salt cake
P2 = PUREX HLW
SRR = Strontium recovery waste.

D3.2 EVALUATION OF SAMPLE AND PROCESS FLOWSHEET INFORMATION

Waste samples from tank 241-AX-101 are limited to sludge samples collected before the tank was sluiced in 1976 and a supernatant sample collected in 1980. These samples are of limited use in establishing the tank contents.

Review of Anderson (1990) and Agnew et al. (1997a) indicate the following chain of events is probable to have occurred:

- Between startup in 1965 and sluicing in 1976, tank 241-AX-101 was used to store various wastes generated by PUREX and Waste Fractionization.

- In 1976 tank 241-AX-101 was sluiced to a 11.4 kL heel. This met the sludge heel requirement for tanks scheduled to be used for salt cake storage of a 2.5 to 5 cm (1 to 2 in.) sludge heel. The requirement was based on radiolytic heating temperature control limits (Rodenhizer 1987).

- 2,547 kL (673 kgal) of solids were accumulated in the tank by the end of 1977. The solids are identified as EVAP, RESID, and DSSF. These are all evaporator concentrates made from tank waste supernates.

- At the end of 1979, supernatant from tank 241-AX-101 was sent to the 242-A Evaporator. Evaporator product, potentially from a different source was returned to the tank.

- In 1980, the tank was used to stage supernatant and first pass slurry to the 242-A Evaporator. The solids level was measured as 1,094 kL (289 kgal).

- At the end of 1980, the tank was filled with DSSF, bringing the solids level to 1,987 kL (525 kgal).

- Cooling of the waste caused additional salt precipitation, bringing the solids level to 2,831 kL, (748 kgal).

From these observations it is concluded that the tank layers defined by the HDW model are reasonable but that the layer defined as P2 sludges is not consistent with process history. Rather, the layer described as P2 sludge is most reasonably ascribed to salt cake.

Of the alternatives available for establishing the composition of the waste in tank 241-AX-101, the only practical method is to use sample data for the same waste type from another tank. The SORWT Model groups 241-A-101, 241-A-102, 241-A-103, and 241-AX-101 as similar tanks. Both 241-A-102 and 241-A-103 have been sampled. However the history of 241-A-102 is somewhat unique. Tank 241-A-102 was the 242-A Evaporator feed tank rather than a salt cake receiver tank during the time period that 241-AX-101 was filled. Use of data from both 241-A-102 and 241-A-103 is recommended to represent the two populations of salt cake receiver and feed tank.

A tank-by-tank review of the HDW model was completed to identify other tanks with the waste layers found in tank 241-AX-101. Tanks 241-A-106 and 241-C-104 were found to contain some of the waste layers found in 241-AX-101, however 241-A-106 has not been sampled, and the layers in 241-C-106 are too thin to discriminate from each other

Relative to the expected waste types in 241-AX-101, tank 241-A-102 has less contribution from the SMMA1 layer and more contribution from the other layers. The relative contribution of the layers for these two tanks is compared in Table D3-7. Use of the data from tank 241-A-102 is also biased by this tank being the evaporator feed tank. In this capacity it would tend to preferentially accumulate those salts that first precipitate, e.g. $NaNO_3$. Thus, the use of samples from both tanks 241-A-102 and 241-A-103 is expected to better represent the salt cake present in tank 241-AX-101 than from 241-A-102 only.

Table D3-7. Relative Volume of Layers in Tanks 241-A-102 and 241-AX-101.

Waste type	Tank 241-A-102 (vol%)	Tank 241-AX-101 (vol%)
SRR	8.1	0.4
SMMA1	51	99.6
SMMA2	40	0

SMMA1 = Supernatant Mixing Model A1 salt sake
SMMA2 = Supernatant Mixing Model A2 salt cake
SRR = Strontium recovery.

Photos of 241-AX-101 tank interior show a yellow-grey to grey salt cake surface with no liquid showing.

D3.3 DOCUMENT ELEMENT BASIS

This section compares the inventory estimate derived from similar tanks to the inventory estimate calculated by the HDW model.

Aluminum. The estimate derived from similar tanks, and the HDW model estimate for aluminum are 92,900 kg, and 116,000 kg respectively. These values are not considered to be significantly different.

Bismuth. The estimate derived from similar tanks, and the HDW model estimate for bismuth are 2,560 kg and 650 kg, respectively. The process history of 241-AX-101 does not identify a source of bismuth and this analysis probably overestimates the bismuth inventory. The material may be due to carryover of $BiPO_4$ waste solids heel in tanks 241-B-111 or 241-B-112.

Calcium. The estimate derived from similar tanks, and the HDW model estimate for calcium are 7,140 kg and 3,240 kg, respectively. There is no technical basis to establish the reason for the difference between the estimates. Usually the HDW estimate is seen as high in calcium.

Iron. The estimate derived from similar tanks, and the HDW model estimate for iron are 36,900 kg and 8,370 kg, respectively. There is no technical basis to establish the reason for the difference between the estimates. Usually the HDW model estimate is seen as high in iron. The HDW model estimate will be used for the best-basis since a large inventory of an insoluble species is not expected in a salt cake.

Manganese. The estimate derived from similar tanks, and the HDW model estimate for manganese are 6,090 kg and 645 kg, respectively. There is no technical basis to establish the reason for the difference between the estimates. The HDW model does not delineate manganese in the OWW waste.

Silicon. The estimate derived from similar tanks, and the HDW model estimate for silicate are 58,000 kg and 7,570 kg, respectively. There is no technical basis to establish the reason for the difference between the estimates. It may be possible that tanks 241-A-102 and 241-A-103 contain some undissolved silica heel from the AR vault in this tank estimate.

Sulfate. The estimate derived from similar tanks, and the HDW model estimate for sulfate are 19,000 kg and 70,600 kg, respectively. There is no technical basis to establish the reason for the difference between the estimates except due to the sulfate ascribed by Agnew (1997a) as present in P2 waste.

Phosphate. The estimate derived from similar tanks, and the HDW model estimate for phosphate are 44,200 kg and 22,500 kg, respectively. There is no technical basis to establish the reason for the difference between the estimates. However the presence of phosphate in Tri-butyl phosphate (TBP) from OWW waste and dissolved TBP may contribute to the difference.

Total Inorganic Carbon. The estimate derived from similar tanks, and the HDW model estimate for total inorganic carbon are 91,700 kg and 79,200 kg, respectively. These values are not considered to be significantly different.

Total Hydroxide. Once the best-basis inventories were determined, they hydroxide inventory was calculated by performing a charge balance with the valences of other analytes. In some cases, this approach requires that other analyte (e.g., sodium or nitrate) inventories be adjusted to achieve the charge balance. During such adjustments, the number of significant figures is not increased. This charge balance approach is consistent with that used by Agnew et al. (1997a)

Uranium. The estimate derived from similar tanks, and the HDW model estimate for uranium are 41,300 kg and 4,910 kg, respectively. No significant source of uranium was identified by review of contributing waste types for tank 241-AX-101. The uranium value determined by evaluation of similar tanks is thus considered unlikely to be representative of tank 241-AX-101.

D4.0 DEFINE THE BEST-BASIS AND ESTABLISH COMPONENT INVENTORIES

Key waste management activities include overseeing tank farm operations and identifying, monitoring and resolving safety issues associated with those operations and with the tank wastes. Disposal activities involve designing equipment, processes and facilities for retrieving wastes and processing them into a form that is suitable for long-term storage. Information about chemical, radiological and/or physical properties is used to perform safety analyses, engineering evaluations, and risk assessment associated with these activities.

Chemical and radiological inventory information are generally derived using three approaches: (1) component inventories are estimated using the results of sample analyses, (2) component inventories are predicted using the HDW model, process knowledge, and historical information, or (3) a tank-specific process estimate is made based on process flowsheets, reactor fuel data, essential material usage and other operating data.

The results from the best-basis evaluation support using the results of an engineering evaluation as the best basis for tank 241-AX-101 for the following reasons.

1. Sample data is not available for tank 241-AX-101.

2. The large number of waste types that are in the tank or were added to the tank and later removed has resulted in a tank history that is sufficiently complex that comparison to process flowsheets is impractical.

3. The engineering evaluation is based on tanks (tank 241-A-102 and 241-A-103) with a similar process history for which sample data exists and upon minor amounts of SRR sludge based upon Agnew et al. (1997a).

Best-basis tank inventory values are derived for 46 key radionuclides (as defined in Section 3.1 of Kupfer et al. 1997), all decayed to a common report date of January 1, 1994. Often, waste sample analyses have only reported ^{90}Sr, ^{137}Cs, $^{239/240}$Pu, and total uranium (or total beta and total alpha), while other key radionuclides such as ^{60}Co, ^{99}Tc, ^{129}I, ^{154}Eu, ^{155}Eu, and ^{241}Am, etc., have been infrequently reported. For this reason it has been necessary to derive most of the 46 key radionuclides by computer models. These models estimate radionuclide activity in batches of reactor fuel, account for the split of radionuclides to various separations plant waste streams, and track their movement with tank waste transactions. (These computer models are described in Kupfer et al. 1997, Section 6.1 and in Watrous and Wootan 1997.) Model generated values for radionuclides in any of 177 tanks are reported in the HDW Rev. 4 model results (Agnew et al. 1997a). The best-basis value for any one analyte may be either a model result or a sample or engineering assessment-based result if available. (No attempt has been made to ratio or normalize model results for all 46 radionuclides when values for measured radionuclides disagree with the model.) For a discussion of typical error between model derived values and sample derived values, see Kupfer et al. 1997, Section 6.1.10.

Best-basis inventory estimates for tank 241-AX-101 are presented in Tables D4-1 and D4-2. The inventory values reported in Tables D4-1 and D4-2 are subject to change. Refer to the Tank Characterization Database (TCD) for the most current inventory values.

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-AX-101 (Effective May 31, 1997).

Analyte	Total Inventory (kg)	Basis (S, M, E or C)[1]	Comment
Al	92,900	E	
Bi	2,560	E	
Ca	7,140	E	
Cl	21,100	M	
TIC as CO_3	91,700	E	
Cr	18,100	E	
F	1,170	E	
Fe	8,370	M	
Hg	5.08	M	
K	11,600	E	
La	434	E	
Mn	6,090	E	
Na	775,000	E	
Ni	1,190	E	
NO_2	351,000	E	
NO_3	523,000	E	
OH	344,000	C	
Pb	3,500	E	
P as PO_4	44,200	E	
S as SO_4	19,000	E	
Si	58,000	E	
Sr	161	E	
TOC	40,900	E	
U_{TOTAL}	4,910	M	
Zr	3,470	E	

[1]S = Sample-based
M = Hanford Defined Waste model-based, Agnew et al. (1997a)
E = Engineering assessment-based
C = Calculated by charge balance; includes oxides as hydroxides, not including CO_3, NO_2, NO_3, PO_4, SO_4, and SiO_3.

Table D4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-AX-101 Decayed to January 1, 1994 (Effective May 31, 1997). (2 Sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{3}H	0.943	E	
^{14}C	7.91	E	
^{59}Ni	6.93	E	
^{60}Co	700	E	
^{63}Ni	681	E	
^{79}Se	3.86	E	
^{90}Sr	1.25 E+06	E	
^{90}Y	1.25 E+06	E	Calculated from Parent
^{93m}Nb	14.3	E	
^{93}Zr	16.7	E	
^{99}Tc	458	E	
^{106}Ru	0.030	E	
^{113m}Cd	35.5	E	
^{125}Sb	0.919	E	
^{126}Sn	6.20	E	
^{129}I	0.103	E	
^{134}Cs	0.111	E	
^{137}Cs	604,000	E	
^{137m}Ba	571,000	E	Calculated from Parent
^{151}Sm	14,400	E	
^{152}Eu	3.61	E	
^{154}Eu	84.9	E	
^{155}Eu	221	E	
^{226}Ra	4.66 E-04	E	
^{227}Ac	0.0024	E	
^{228}Ra	2.11 E-09	E	
^{229}Th	3.51 E-07	E	
^{231}Pa	0.0036	E	
^{232}Th	2.85 E-11	E	
^{232}U	9.31 E-08	E	
^{233}U	1.31 E-09	E	

Table D4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-AX-101 Decayed to January 1, 1994 (Effective May 31, 1997). (2 Sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{234}U	3.90 E-04	E	
^{235}U	1.52 E-05	E	
^{236}U	2.57 E-05	E	
^{237}Np	0.0016	E	
^{238}Pu	5.42	E	
^{238}U	3.12 E-04	E	
$^{239/240}Pu$	5,020	E	
^{241}Am	2,940	E	
^{241}Pu	384	E	
^{242}Cm	0.137	E	
^{242}Pu	0.0023	E	
^{243}Am	0.0086	E	
^{243}Cm	0.0124	E	
^{244}Cm	0.502	E	

[1]S = Sample-based
M = Hanford Defined Waste model-based, Agnew et al. (1997a)
E = Engineering assessment-based.

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D5.0 APPENDIX D REFERENCES

Agnew, S. F., J. Boyer, R. A. Corbin, T. B. Duran, J. R. FitzPatrick, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1997a, *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 4*, LA-UR-96-3860, Los Alamos National Laboratory, Los Alamos, New Mexico.

Agnew, S. F., R. A. Corbin, T. B. Duran, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1997b, *Waste Status and Transaction Record Summary (WSTRS Rev. 4)*, LA-UR-97-311, Rev. 0, Los Alamos National Laboratory, Los Alamos, New Mexico.

Anderson, J. D., 1990, *A History of the 200 Area Farms*, WHC-MR-0132, Westinghouse Hanford Company, Richland, Washington.

Hanlon, B. M., 1996, *Waste Tank Summary Report for Month Ending May 31, 1996*, WHC-EP-182-99, Westinghouse Hanford Company, Richland, Washington.

Hill, J. G., G. S. Anderson, and B. C. Simpson, 1995, *The Sort on Radioactive Waste Type Model: A Method to Sort Single-Shell Tanks into Characteristic Groups*, PNL-9814, Rev. 2, Pacific Northwest Laboratory, Richland, Washington.

Hodgson, K. M., and M. D. LeClair, 1996, *Work Plan for Defining a Standard Inventory Estimate for Wastes Stored in Hanford Site Underground Tanks*, WHC-SD-WM-WP-311, Rev. 1, Lockheed Martin Hanford Corporation, Richland, Washington.

Jo, J., B. J. Morris, and T. T. Tran, 1996, *Tank Characterization Report for Single-Shell Tank 241-A-102,* WHC-SD-WM-ER-597, Westinghouse Hanford Company, Richland, Washington.

Kupfer, M. J., A. L. Boldt, B. A. Higley, K. M. Hodgson, L. W. Shelton, B. C. Simpson, and R. A. Watrous (LMHC), S. L. Lambert, and D. E. Place (SESC), R. M. Orme (NHC), G. L. Borsheim (Borsheim Associates), N. G. Colton (PNNL), M. D. LeClair (SAIC), R. T. Winward (Meier Associates), and W. W. Schulz (W^2S Corporation), 1997, *Standard Inventories of Chemicals and Radionuclides in Hanford Site Tank Wastes*, HNF-SD-WM-TI-740, Rev. 0, Lockheed Martin Hanford Corporation, Richland, Washington.

Kummerer, M., 1995, *Heat Removal Characteristics of Waste Storage Tanks*, WHC-SD-WM-SARR-010, Westinghouse Hanford Company, Richland, Washington.

Lambert, S. L., and D. W. Hendrickson, 1997, *Preliminary Tank Characterization for Single-Shell Tank 241-AX-103: Best Basis Inventory*, HNF-SD-WM-ER-685, Rev. 0, SGN Eurysis Services Corporation, Richland, Washington.

Rodenhizer, D. G., 1987, *Hanford Waste Tank Sluicing History*, WHC-SD-WM-TI-302, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Weiss, R. L. and K. E. Schull, 1988, *Data Transmittal Package for Tank 241-A-102 Waste Tank Characterization*, SD-RE-TI-201, Rockwell Hanford Company, Richland, Washington.

Watrous, R. A., and D. W. Wootan, 1997, *Activity of Fuel Batches Processed Through Hanford Separations Plants, 1944 Through 1989,* HNF-SD-WM-TI-794, Rev. 0, Lockheed Martin Hanford Corporation, Richland, Washington.